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FOR CONSIDERATION.

Proposed Course

IN

Elementary Science

FOR

High and Continuation Schools

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ELEMENTARY SCIENCE.

PREFATORY MEMORANDUM.

In the following revised course in Elementary Science the Department of Education seeks to correct the defects which have been found in the present course. It is now placed in the hands of the science teachers of the Province for consideration until the close of next half-year. Since the course is not essentially different from that of 1904, science teachers may, with the consent of the Principal, follow it for the present session.

ZOOLOGY.

A TWO YEARS' COURSE.

General Scope of the Work : In this course in elementary Zoology the two sides of animal study are distinguished and outlined. On the one hand, is prescribed a general laboratory course which embodies the simple morphological study of common forms, representing the chief animal types. On the other hand, an outline of work on the natural history side of the subject is suggested. These are not two distinct courses. It is intended that the work of the laboratory shall be such as to help in the interpretation of the outdoor observations and incite to deeper enquiry; while the studies in natural history will make the indoor study interesting and necessary. The work in natural history will be a logical and safe foundation for the work in science taught through modern laboratory methods.

Outdoor Work : The teacher's immediate responsibility lies in the laboratory work. The outdoor work, which will of necessity vary with the locality, must be carried on to a very large extent without his direct supervision. But the teacher should encourage and direct the pupils, devoting a fair portion of the time of the class to discussions and reports on their independent work. Arrangements should be made for field excursions on suitable occasions.

Selective Studies : The selective studies, appended to the regular work, are intended to be suggestive. In them, is offered freedom to select such topics as time, place, and circumstances may permit the teacher to use.

Indoor Study of Living Animals : The morphological studies in the laboratory are, wherever possible, to be supplemented or preceded by observation on living specimens. For this purpose, provision will be needed for suitable aquaria and vivaria, where the moving, breathing, and feeding of the living animals may be within ready view of the pupils. *Moreover, these morphological studies are not to end in the study of form; behind the observation of the form, there must be a constant effort to interpret the* MEANING *of the form, to show the relation of form and function.*

School Museum : For progress in the natural history side of the subject collections of specimens of the local fauna will have to be made. The school museum should be a thing of gradual growth, and great care should be taken in the selection of the material. As occasion offers, it should be provided with specimens of local fish, frogs, reptiles, birds, insects, etc.

FIRST YEAR—SEPTEMBER AND OCTOBER.

Laboratory Work.

INVERTEBRATES.—Class study of a grasshopper, a spider, a centipede.

Selective studies : Comparison of a grasshopper with a cricket or cockroach, leading to the recognition of the order Orthoptera ; study of a butterfly, a bee, a potato beetle, a house fly, a bug or a dragon fly, as representatives of the other orders ; observation of bees in a laboratory bee-hive ; instruction in the collecting and mounting of insects.

VERTEBRATES.—*Birds :* Study of external characters of a domestic fowl, pigeon or other common bird ; comparison of the bills, wings, legs, and feet of different types of birds.

Selective studies : Structure of feathers ; structure of an egg ; chief skeletal characteristics of birds ; demonstration of viscera ; instruction regarding the protection of birds by law.

Outdoor Work.

Observation of the habits and development of the insects studied in the laboratory ; preparation of a small collection of insects ; how insects visit and use flowers ; how spiders weave their webs and secure their food ; collection of caterpillars for observation of their metamorphosis during the following winter and spring.

Recognition of the common wild birds of the locality ; observation of their habits and of their adaptation to their different modes of living ; times and modes of their southward migrations ; recognition of the different varieties of pigeons, ducks, geese and chickens that may be seen in the neighborhood or at fall fairs.—*For the Winter :* Observation of the winter birds, their feeding habits, their dangers, their modes of protection.

APRIL, MAY AND JUNE

Laboratory Work.

INVERTEBRATES.–Class study of the mosquito, the fresh water clam or the common garden slug, the earthworm.

VERTEBRATES.–*Fish :* Study of the external characters of a common fish.

Selective studies : Structure of gills and the manner of breathing ; microscopic demonstration of the structure of a scale ; demonstration of viscera ; chief skeletal characteristics.

Amphibians : Study of the external characters of a common frog or the common garden toad ; and of the development of the animal from the egg. Economic importance of frogs and toads.

Selective studies : Chief skeletal characteristics ; demonstration of the viscera ; demonstration of the blood flow in the tail of the tadpole or the web of the frog's foot ; estimation of the number of young produced and the proportion that may reach maturity. *Birds* : Demonstration of the first three days' development of a chick embryo.

Outdoor Work.

Observations on the life histories and habits of economic insects, such as those suggested for study in the next term ; collections of these insects ; observations on the prevalence of mosquito larvæ in wet places and their destruction by kerosene : observation of the means employed by gardeners and others for combating insect pests ; examination of spraying appliances ; observations on beekeeping and the production of honey.

Observation of the habits of earthworms, such as their appearance after rain, their castings on the garden paths, their depth in the ground in dry weather, their injury to lawns, their destruction by robins.

Recognition of the common fish of the district and observation of their habits; observation of the food fish sold in the local market; methods of rearing fish in government fish hatcheries.

Recognition of the common frogs, tree frogs, toads, and salamanders; observations of their habits and calls.

Observation of spring migrations of birds, and the feeding and nesting habits of summer residents; recognition of bird songs.

SECOND YEAR—SEPTEMBER AND OCTOBER.

Laboratory Work.

INVERTEBRATES.—Class study of examples of such beneficial or injurious insects as may have local interest in affecting field crops, gardens, orchards, forests, cattle or the household.

VERTEBRATES.—*Mammals:* Study of the external characters of a cat, dog or rabbit; comparison of the hair, teeth, feet and locomotion of some typical mammals, such as the squirrel, mole, bat, cow, horse, cat.

Selective studies:—Chief skeletal characteristics of a mammal, such as the cat; recognition and relationship of the larger bones; demonstration of the viscera.

Outdoor Work.

Observation of the conspicuous insect pests of the season, the methods of attack, the injury done by them, the effect of spraying or other treatment; collection of economic insects.

Recognition of habits of our wild and domestic mammals; economic uses of domesticated mammals; recognition of the different breeds of farm animals, horses, cows, sheep, swine; comparison of the different breeds of dogs, cats, rabbits; preparation for winter and winter habits of wild animals found in the district; uses and values of skins and furs.

APRIL, MAY AND JUNE.

Laboratory Work.

INVERTEBRATES.—Class study of a crayfish and a wood louse.

Selective Studies: Other animal forms that have an economic or natural history interest, such as sponge, coral, starfish, or the minute forms found in ponds or stagnant infusions.

VERTEBRATES.—*Reptiles:* Study of the external characters of a snake and a turtle.

The class work of this term will be largely given to reviewing, summarizing, comparing and classifying.

Outdoor Work.

Continuation of the observation of the life and habits of the animals studied previously.

Recognition of the common snakes and turtles of the locality and observation of their habits; how they pass the winter; how the young are hatched.

BOTANY.

A TWO YEARS' COURSE.

Remarks similar to those introducing the course in zoology will apply also to the work in botany. In particular it is urged upon the instructor that he should constantly stimulate the effort to interpret the meaning of the forms under observation—to discover where possible the relation between form and function.

First Year.—September and October.

Laboratory Work.

The Plant as a Whole: A detailed study of some common plant, such as a petunia or a buttercup, taking up the structure and functions of all the parts in succession: root, stem, foliage-leaves, flower leaves, fruit, and seed; the study at this stage to be such as can be carried on with the aid of an ordinary lens.

Fruits: Structure and classification of the simpler fruits, such as pea or bean, shepherd's purse, poppy, apple, tomato, grape, plum, maize or wheat, maple, etc. Adaptations for dispersal of seeds.

Seeds: Practical study of some common seeds, such as pea, bean, morning-glory, representing dicotyledons; maize, wheat, onion, representing monocotyledons; pine or spruce, representing gymnosperms; form, markings, parts and their functions, position of stored food.

Preparation for Winter: Annuals (including winter annuals, such as winter wheat), biennials, perennials. Storage of reserve food in root, stem, leaf and seed. Study of winter buds, their arrangement, structure, and means of protection. The fall of fruit and leaf. Interpretation of marks on trees and shrubs.

Outdoor Work.

Recognition of common annuals, winter annuals, biennials and perennials of the garden and the field. Observation of winter buds, of change in color, and of time of falling of leaves of trees and shrubs. Study of marks on trees and shrubs. Collections of common flowering plants, weeds, and weed seeds to be begun.

April, May and June.

Laboratory Work.

Study of Spring Flowers: Plant-description and indentification by means of a flora; relation of flower-structure to mode of pollination; meaning and significance of cross-pollination.

Germination of Seeds: Simple experiments to illustrate the more important phenomena and requirements of germination and growth, *e.g.*, need of air, warmth, and moisture; evolution of carbon dioxide; how and to what extent water is absorbed; germinating power.

Artificial Plant Propagation: Cuttings, layering, budding, grafting.

Roots: Varieties of root-forms; root-hairs; root-cap; region of growth.

Stems: Expanding of winter buds; varieties of stem-forms: erect, prostrate, climbing, twining, subterranean, aquatic; adaptation of form to habit. Spines, prickles, tendrils; their forms and uses. Stem-structure in dicotyledons and monocotyledons.

Foliage-Leaves: General structure, including epidermis, stomata, chlorophyll, veins. Protective structures, such as hairs, waxy coatings, etc. Form and arrangement of leaves in relation to sunlight and shedding of rain. Sleep-movements.

NOTE.—*The preceding work on roots, stems, and leaves may be taken up incidentally in connection with the study of spring flowers.*

Outdoor Work.

Observation and recording of the time of leafing and of flowering of common wild and cultivated plants. Habitats of spring-flowering plants; conditions governing growth; insect visitors; methods of pollination. Observation of opening and closing of flowers as shown by dandelion, tulip, hepatica, etc. Time of sowing and rate of germination of garden and farm seeds. Mode of climbing of such plants as sweet pea, morning-glory, grape, Boston ivy, Virginia creeper, hop, galium, clematis, etc. Leaf-arrangement to secure best exposure to light and to shed rain. Diurnal and nocturnal positions of leaves, such as those of clover, honey-locust, oxalis (so-called shamrock), etc. Collections begun in the autumn to be continued.

SECOND YEAR.—SEPTEMBER AND OCTOBER.

Laboratory Work.

Composites: Study of typical composites, such as dandelion, burdock, and ox-eye daisy.

Weeds: Identification of common forms; their seeds; how they spread; and how they may be controlled.

Fungi: Recognition and mode of life of mushroom, puff-ball, polypore, as saprophytic forms; and apple scab, lilac mildew, wheat rust, black knot, or other common type, as a parasitic form.

Physiological Experiments: *Roots.* Simple experiments to illustrate root-functions, *e.g.*, absorption by osmosis, growth towards moisture. *Soils.* Soluble and insoluble materials in soils, and importance of each to the plant; simple experiments in illustration. *Stems.* Simple experiments to illustrate stem-functions, *e.g.*, conduction of cell-sap, heliotropism, rotation of the end of the stem in twiners and climbers. *Foliage-leaves.* Simple experiments to illustrate leaf-functions, *e.g.*, transpiration, manufacture of starch in sunlight, disappearance of starch in darkness, exhalation of a gas by green water-plants in sunlight, exhalation of carbon dioxide.

Outdoor Work.

Recognition and collection of autumn-flowering plants. Collection and recognition of weed seeds in grain screenings. Observation of injurious effects of parasitic fungi, as seen in the rotting, etc., of fruits, such as apples, grapes, plums, etc.

April, May and June.

Laboratory Work.

Trees: Common orchard and forest trees; modes of branching; identification by leaves, bark, wood; uses. Special study of the conifers: the bud, leaf, and flower.

Flower Study Continued: Identification of cultivated and wild spring flowers. Study of a common grass, such as orchard-grass, Indian corn, or wheat.

Ferns: General structure and habits of a common fern.

Economic Products: Summary of economic uses of plants: for timber, food, clothing, decoration, medicine, etc.

Review: General view and comparison of the characteristics of the larger groups of plants taken up in the course, summarizing and classifying.

Outdoor Work.

Observations on plant-societies: plants of the forest, the meadow, the roadside, the pond, the marsh, the garden (weeds), the rocks, noting adaptations to environment. Observation of nodules on the roots of leguminous plants, and enrichment of the soil thereby. Observations of imported and domestic economic plant-products in market, store, and factory.

Collections to be continued.

PHYSICS AND CHEMISTRY.

A TWO YEARS' COURSE.

PHYSICS.

Introductory: Measurement in Metrical and English units of length, area, volume, and mass; structure and use of the Balance.

The Three States of Matter: Defined and explained, Molecular Theory.

Mechanics: The principle of the mechanical powers, especially the lever, the screw, the pulley, and the wheel and axle, with some of their more important simple applications.

Hydrostatics: Pascal's Law, statement and verification, some of its more important applications; pressure of liquids in its relation to direction, depth; density of liquid, area pressed, and shape of containing vessel; Archimedes principle; specific gravity, common methods of finding specific gravities of solids, liquids, and gases.

Pneumatics: Study of the properties of a gas as exhibited in air as a type; proof that air has weight, occupies space, and exerts pressure; construction of the barometer; the relation between the volume and pressure of a gas; proof of Boyle's Law; practical applications of air pressure, air-pump, common pump, siphon, air-brakes, air-tools; meaning of wind pressure; some of the more important applications of wind pressure.

Heat: Nature and source of heat; experiment to illustrate the expansion of solids, liquids, and gases by heat; some practical applications of the principle of expansion; the anomalous expansion of water, its significance.

Thermometry: Meaning of temperature, construction of mercury thermometer, graduation of the thermometer in the centigrade and the Fahrenheit scales, meaning of absolute temperature; laws of fusion; laws of boiling; evaporation and dew point; the effects of large bodies of water on climate; meaning of specific heat; latent heat of fusion; latent heat of vaporization; latent heat as affecting climate; brief description of the working of the steam engine; heating and ventilation by stoves, hot air furnaces, hot water, and steam.

Sound: Nature and propagation of sound; pitch of sound; consonance and resonance; string musical instruments, wind musical instruments; reflection of sound, echoes.

Light: Nature and propagation of light; simple experiments illustrating the reflection and refraction of light; dispersion of light; color of bodies.

Magnetism and Electricity: Magnets; laws of magnetic attraction and repulsion; polarity; magnetic induction; terrestrial magnetism; construction of simple voltaic cell; decomposition of water by electricity; electro-magnet, telephone, telegraph, and electric bell; heating and lighting effects of the current; simple experiments to illustrate the principle of electric lighting; simple experiments to illustrate the principle of the dynamo and motor.

CHEMISTRY.

A study of air and its constituents, a study of water and its constituents, a study of limestone and its decomposition—products, quicklime and carbon dioxide. Mixture, chemical compound, element, physical and chemical change.

Optional.

(When more than the minimum of time is provided).

Heat: The measurement of quantity of heat; finding the specific heat of solids and liquids; finding the latent heat of fusion and latent heat of vaporization.

Light: Verification of law of inverse squares; measurement of candle-power of radiants with photometer; position and character of images formed by plane and spherical mirrors; position and character of images formed by spherical lenses.

Electricity: Simple experiments in electrical measurements; fuller and more exact description of the more important applications of the electric current.

EXTRACT FROM CIRCULAR No. 9, JULY, 1908.

The minimum time prescribed for Elementary Science shall be:—

(*a*) For Biology, a lesson in each year of the Lower School, of thirty minutes every day during the months of September and October and from the beginning of April to the end of June; or the equivalent thereof.

(*b*) For Physics and Chemistry, a lesson, in each year of the Lower School, of thirty minutes three times a week, or the equivalent thereof, during the rest of the school year.

The courses in Botany, Zoology, Physics, and Chemistry shall be taken up practically throughout. A recent investigation among the prospective teachers in the Faculties of Education and the Normal Schools has revealed an unsatisfactory condition of affairs in the matter of practical work in Science done by the pupils, especially in Physics, in all the forms of a very large number of the High and Continuation Schools and Collegiate Institutes of the Province. Regulation 2 (2), (*b*) of Circular 19, Oct., 1907, provides that the official form of application for admission to the Entrance Examination of any of the professional training schools shall include a certificate signed by the Principal that the candidate has taken up practically the course in Science. It is the duty of each School Board to provide adequate equipment and accommodations and of the Science Master to comply with the foregoing requirements. Without these, the Principal cannot give the certificate.

EDUCATION DEPARTMENT,
October, 1908.